भारतीय मानक
Indian Standard

IS 17216 : 2019

कृषि और बागवानी के लिए पॉलीथीन पलवार फिल्म — विशिष्टि

Polyethylene Mulch Films for Agriculture and Horticulture — Specification

ICS 83.140.10

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भारतीय मानक ब्यूरो
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Plastics Sectional Committee, PCD 12

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

The practice of mulching in agriculture is very old. Crop residue, paper, soil, pebbles and synthetic materials have been used as mulches under diverse agro-climatic conditions. The polyethylene mulch application has gained popularity among farmers. The main objectives of polyethylene mulching have been water conservation, weed control and soil temperature control. However, pest control and carbon dioxide (CO_2) enrichment have also been observed as benefits of mulching. With the advent of polyethylene films, it has been possible to achieve the whole range of benefits provided the right kind of material is used correctly. Polyethylene mulching has become very relevant for sustainable environment friendly agriculture, because it reduces the requirements of fertilizer and agro-chemicals by better utilization efficiency. The polyethylene mulching also reduces soil erosion.

A need has been felt to formulate this standard to guide prospective users to select appropriate polyethylene mulch films for the intended applications and use it correctly. Polyethylene mulch film provides favourable soil moisture for development of roots and plants, prevents weed growth, conserves water, effective in dry land farming, prevents soil erosion and run off etc.

Various types of polyethylene mulch films, like transparent, black, colored, reflective films are used in agriculture/horticulture for different purposes. Generally, the polyethylene film is first laid on ground and holes are made near plant stem. The polyethylene mulch film with drip irrigation is a very popular application.

Coverage area of polyethylene mulch film is given in informative Annex C.

The composition of the Committee responsible for the formulation of this standard is given at Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*).' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

POLYETHYLENE MULCH FILMS FOR AGRICULTURE AND HORTICULTURE PURPOSE — SPECIFICATION

1 SCOPE

1.1 This standard prescribes the requirements and methods of sampling and tests for polyethylene mulch films for agriculture and horticulture purpose.

1.2 The polyethylene mulch films of thickness below 30 microns have not been considered because retrieval of film from the field is not possible because of degradation of the film when in use.

NOTE — This standard does not cover compostable polyethylene mulch films.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No./Other Publication	*Title*
245 : 1988	Specification for trichloroethylene (*third revision*)
1070 : 1992	Reagent grade water — Specification (*third revision*)
1747 : 1972	Specification for nitrogen (*first revision*)
2530 : 1963	Methods of test for polyethylene moulding materials and polyethylene compounds
4905 : 2015	Random sampling and randomization procedures (*first revision*)
7016 (Part 1) : 1982	Methods of test for coated and treated fabrics: Part 1 Determination of roll characteristics (*first revision*)
13360	Plastics — Methods of testing
(Part 3/Sec 10) : 2016	Physical and dimensional properties, Section 10 Determination of density of non-cellular plastics — Immersion method, liquid pyknometer method and titration method
(Part 4/Sec 1) : 2000	Rheological properties, Section 1 Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermos polyethylene
(Part 5/Sec 3) : 2018	Mechanical properties, Section 3 Determination of tensile properties — Test condition for film and sheets
(Part 5/Sec 6) : 1999	Mechanical properties, Section 6 Determination of impact resistance by the free-falling dart method — Staircase methods
(Part 5/ Sec 23) : 1996	Mechanical properties, Section 23 Determination of tear resistance of plastics film and sheeting — Elmendorf method
(Part 9/Sec 5) : 1999	Optical properties, Section 5 determination of haze and luminous transmittance of transparent polyethylene
(Part 11/Sec 1) : 1999	Special properties, Section 1 Film and sheeting — Determination of coefficients of friction
ISO 4892-3 : 2016	Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Non Reflective Polyethylene Mulch Film — The Polyethylene mulch film which provides barrier for light and water when laid above ground to cover substantial area under crop canopy.

3.2 Reflective Polyethylene Mulch Film — The Polyethylene mulch film which acts as reflective top surface for the sunlight minimizing the heat absorption, however provides barrier for water when laid above ground to cover substantial area under crop canopy.

4 TYPES

Polyethylene mulch film shall be of following two types:

a) Non reflective polyethylene mulch films; and
b) Reflective polyethylene mulch film.

5 REQUIREMENTS

5.1 Materials

5.1.1 *Density*

The density of polyethylene resin from which polyethylene mulch film is made shall be between 0.908 to 0.930 g/cm^3 at 27°C (0.910 to 0.932 g/cm^3 at 23°C) when determined in accordance with IS 13360 (Part 3/Sec 10).

5.1.2 *Melt Flow Index*

The melt flow index of in accordance with IS 13360 (Part 4/Sec 1) under test temperature of 190°C and polyethylene resin from which mulch film is made shall be between 0.1 to 2.5 g/10 min when determined test load of 2.16 kg.

5.1.3 Master batch shall be filler free. Any additives other than carbon black master batch added to resins shall be agreed between the supplier and the purchaser.

5.1.4 Carbon black used in carbon black master batch shall comply with the following requirements:

a) Density — 1.5 to 2.0 g/ml at 27 ± 2°C;
b) Toluene extract*, Max* — 0.1 percent (*m/m*);
c) Volatile matter, *Max* — 0.9 percent (*m/m*);
d) Carbon black particle size — less than 0.025 µ (25 nm); and
e) Tint strength*, Min* — 115.

NOTE — A test report or confirmative certificate may be obtained from the carbon black master batch manufacturer.

5.1.5 *UV Stabilizer*

Pesticide resistant UV stabilizer must be used in all the layer as per the quantity advised by UV supplier to achieve the required service life.

5.2 General Requirements

5.2.1 *Visual Appearance*

The polyethylene mulch film shall be uniform in colour, texture and finish and substantially free from pin-holes and foreign particles visible to unaided eye. There shall be no visible defects, such as holes, tears and blisters etc. The edges shall be free from nicks and cuts visible to unaided eye.

5.2.2 *Film Form*

The polyethylene mulch film shall be furnished in the form of flat roll/ folded film or in the form of flat tubing or in any other form as agreed to between the supplier and the purchaser.

5.2.3 Colour of the polyethylene mulch film shall be as agreed to between the manufacturer and the purchaser.

5.2.4 *Odour*

The film shall be free from any objectionable odour.

5.3 Physical Requirements

5.3.1 *Dimensions*

5.3.1.1 *Tolerance on thickness*

When tested in accordance with Annex B at 27 ± 2°C, tolerance on nominal thickness at any given point, shall be as follows:

Nominal Thickness	*Tolerance, Percent*
30 to 100 µ	± 10 (on individual thickness)
30 to 100 µ	± 5 (on average thickness)

5.3.1.2 *Tolerance on width*

The width of the film is as agreed between manufacturer and the purchaser. The tolerance on width at any given point shall be – 0 mm
+ 5 mm

5.3.2 *Impact Strength*

When tested in accordance with method A of IS 13360 (Part 5/Sec 6), the impact failure load obtained from a drop height of 66 cm shall not be less than the values given in Table 1 or 2.5 grams/micron.

Table 1 Impact Strength

(*Clause* 5.3.2)

Sl No.	**Nominal Film Thickness (µ)**	**Impact Failure Mass *Min*, gf**
(1)	(2)	(3)
i)	30	75
ii)	40	100
iii)	50	125
iv)	75	190
v)	100	250

NOTE — The values for impact failure loads for intermediate thicknesses may be obtained by interpolation.

5.3.3 *Tensile Strength at Break*

When tested in accordance with IS 13360 (Part 5/ Sec 3), the tensile strength at break shall not be less than 200 kgf/cm² in length wise/machine direction as well as in cross wise/transverse direction.

5.3.4 *Elongation at Break*

When tested in accordance with IS 13360 (Part 5/ Sec 3), the elongation at break shall be not less than 300 percent in length wise/machine direction and 400 percent in cross wise/transverse direction.

5.3.5 *Coefficient of Friction*

When tested in accordance with IS 13360 (Part 11/ Sec 1), the kinetic coefficient of friction shall be in between 0.22 to 0.35.

5.3.6 *Elmendorf Tear Strength*

When tested in accordance with IS 13360 (Part 5/ Sec 23) the minimum tear strength shall be 2 grams/ micron in machine direction and 4 grams/micron in transverse direction.

5.3.7 *Opacity*

When tested in accordance with IS 13360 (Part 9/ Sec 5), the opacity of the mulch film shall be 100 percent. The tolerance on opacity shall be -1 percent.

NOTE — This clause is not applicable for transparent film.

5.4 Requirements for Black Polyethylene Mulch Film

The black polyethylene mulch film shall also comply with the requirements given in Table 2 when tested in accordance to the test method given in column **4** and **5** of Table 2.

Table 2 Requirements for Black Polyethylene Mulch Film

(*Clause* 5.4)

Sl No.	Characteristic	Requirement	Method of Test	
			Ref to IS	Annex
(1)	(2)	(3)	(4)	(5)
i)	Carbon black, percent (*w/w*), *Max*	2.0 to 3.0	—	Annex A
ii)	Ash content, percent (*w/w*), *Max*	0.2	—	Annex A
iii)	Carbon black dispersion	satisfactory	16 of IS 2530	—

NOTE — Higher Carbon black content is permitted to achieve opacity and shall be agreed between manufacturer and the purchaser.

5.5 Service Life

The service life of the mulch film shall be declared by the manufacturer. After guaranteed service life, the tensile strength and elongation at break after exposing UV radiation and weathering shall not be less than 50 percent of the original strength when tested as per the method given in Annex D.

6 PACKING AND MARKING

6.1 Packing

The roll/folded Polyethylene mulch film shall be packed as agreed to between the manufacturer and the purchaser. Manual for installation, making hole and lying of mulch film should be provided by the manufacturer with each roll. Mulch film may also be supplied with ready holes as agreed between manufacturer and the purchaser.

6.2 Marking

Each roll/folded Polyethylene mulch film shall be marked legibly on every meter either brand name or company name. Printed label has to be fixed on the roll with following information.

a) Manufacturer’s name and/or his recognized trade-mark, if any;
b) Batch or lot number in code or otherwise of manufacture;
c) Type of the film;
d) Service life of the film;
e) Month and year of manufacture;
f) Thickness of the film;
g) Width of the film roll/folded film;
h) Mass of the roll/folded film; and
j) Colour of the film, if any.

6.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

7 SAMPLING

7.1 Lot

In any consignment, all rolls/folded Polyethylene mulch films of the same material shall be grouped together to constitute a lot.

7.1.1 Tests for determining the conformity of the lot to the requirements of the specification shall be done on each lot separately. The number of rolls/folded films to be selected for this purpose shall be in accordance with column **1** and **2** of Table 4.

7.1.2 The rolls/folded films shall be selected at random from the lot. In order to ensure randomness of selection, procedures given in IS 4905, may be followed. In case this standard is not readily available, the following procedure may be adopted.

Starting from any roll/folded film in the lot, count them in one order as 1, 2, … etc., up to *r* and so on, where *Y* is the integral part of *N*/*n*. Every r^{th} roll/folded film thus counted shall be withdrawn till the required number of rolls/folded films are taken from the lot.

7.2 Number of Tests and Criteria for Conformity

7.2.1 From each of the rolls/folded films selected according to **7.1.2**, approximately 1 m of the film of full width shall be cut. The test specimens for the various tests shall be cut from different parts of the width of the film.

7.2.2 Each of the pieces as obtained in **7.2.1**, from a lot shall be examined for appearance (*see* **5.1.5**), and dimensional requirements (*see* **5.2**). Any piece which does not meet the requirement of any of the above characteristics shall be considered as defective.

7.2.3 If the number of defectives found (*see* **7.2.2**) is less than or equal to the corresponding permissible number of defectives given in col 3 of Table 3, the lot shall be tested for the remaining requirements of the specification.

7.2.4 The lot having been found satisfactory according to **7.2.3** shall be tested for tensile strength and elongation, impact resistance, melt flow index, density, optical properties, slip, carbon black content and carbon black dispersion.

For this purpose, the rolls/folded film already tested according to **7.2.2** and found satisfactory shall be used for testing of above characteristics. In case there are more than 15 rolls/folded films on selection of sampling in a lot, 15 rolls/folded films shall be selected from them at random for the testing of above characteristics. Composite of three samples shall be tested for melt flow index, carbon black content and carbon black dispersion.

7.2.4.1 The lot shall be deemed to have satisfied these requirements if all the test results for different characteristics given in **7.2.4** are found meeting the relevant requirements of the specification.

7.2.5 The lot shall be declared as conforming to the requirements of the specification, if the requirements for various characteristics as given in **7.2.3** and **7.2.4** are satisfied.

8 QUALITY OF REAGENTS

Unless specified otherwise, pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

Table 3 Scale of Sampling and Permissible Number of Defectives

(*Clause* 7.1.1 *and* 7.2.3)

Sl No. (1)	Lot Size (*N*) (2)	Number of Rolls/Folded Films to be Selected (*n*) (3)	Permissible Number of Defectives (4)
i)	1	1	0
ii)	2 to 15	2	0
iii)	16 to 40	3	0
iv)	41 to 65	5	0
v)	66 to 110	7	0
vi)	111 to 180	10	0
vii)	181 to 300	15	1
viii)	301 to 500	25	1
ix)	501 to 800	35	2
x)	801 to 1 300	50	3
xi)	1 301 and above	75	4

ANNEX A

(*Clause* 5.4 *and Table* 2)

DETERMINATION OF CARBON BLACK AND ASH CONTENT

A-1 APPARATUS

A-1.1 Combustion Boat — Made of porcelain or silica, having minimum dimensions of 75 mm length, 9 mm width and 8 mm height.

A-1.2 Combustion Tube — Made of hard glass, of approximately 30 mm diameter and 400 ± 50 mm length.

A-1.3 Gas Flow Meter — For measuring and controlling the rate of flow of nitrogen within 1.7 ± 0.3 l/min.

A-1.4 Thermometer — In the range 250°C to 550°C.

A-1.5 Furnace — To accommodate the combustion tube and to give temperatures up to at least 500°C.

A-2 REAGENTS

A-2.1 Nitrogen — Gas (*see* IS 1747).

A-2.2 Trichloroethylene (*see* IS 245)

A-3 PROCEDURE

A-3.1 Heat the combustion boat to red heat, allow it to cool in a desiccator for at least 30 min and weigh to the nearest 0.000 1 g. Place about 1 g of the sample of the polyethylene compound, accurately weighed, in the boat. Place the boat with the sample in the middle of the combustion tube. Insert a stopper carrying a thermometer and a tube for the admission of nitrogen into one end of the combustion tube. The thermometer shall be so adjusted that its bulb is in contact with the boat. Pass nitrogen through the combustion tube at a rate of 1.7 ± 0.3 l/min and maintain the same rate of flow during the subsequent heating. Place the combustion tube in the furnace and connect its outlet to two cold traps in series, both containing trichloroethylene and the first being cooled with solid carbon dioxide. Put the outlet tube from the second trap to a fume hood or to the outside atmosphere.

A-3.2 Heat the furnace to 500°C ± 5°C and maintain this temperature for 10 min. Disconnect the outlet tube from the cold traps. Withdraw the combustion tube containing the boat from the furnace and allow to cool for 5 min, maintaining the flow of nitrogen at the same rate as before. Remove the boat from the nitrogen inlet side of the combustion tube, allow it to cool in the desiccator for 20 to 30 min and weigh to the nearest 0.000 1 g (W_1). Heat the boat strongly in air to constant weight (W_2).

A-4 CALCULATION

A-4.1 Carbon black content, percent by weight =

$$\frac{100 \times (W_1 - W_2)}{W_3}$$

A-4.2 Ash content, percent by weight =

$$\frac{100 \times (W_2 - W_4)}{W_3}$$

Where,

W_1 = weight in g, of the boat before heating in air;

W_2 = weight in g, of the boat after heating in air;

W_3 = weight in g, of the material taken for the test; and

W_4 = weight in g, of empty boat.

ANNEX B

(*Clause* 5.3.1.1)

DETERMINATION OF THICKNESS

B-1 APPARATUS

A dead weight dial micrometer with a flat anvil of 6 mm diameter or larger in area and 4.8 mm diameter flat surface on the head of the spindle or a spring dial micrometer (dial thickness gauge) which has been calibrated against a dead weight dial micrometer shall be used. In case of dispute, only dead weight dial micrometer shall be used and the reading shall be taken between 15 s and 2 min after the load is applied.

B-2 SPECIMENS

Test five specimens, at least 5 × 5 cm in area, taken uniformly across the width of the test piece.

B-3 PROCEDURE

Dry and clean the surface of the anvil and spindle head, and of the specimen. Place the specimen on the anvil and lower the spindle head on to it slowly. The total load applied by the spindle shall be 110 g. Make one measurement on each specimen approximately at the center of the specimen. Take mean of the measurements of all the specimens of a sample to obtain the average thickness of the sample.

B-4 ACCURACY

This method is capable of producing measurements with a maximum error of ± 0.000 25 cm.

ANNEX C

(*Foreword*)

(Informative **)**

GUIDELINES — COVERAGE AREA OF POLYETHYLENE MULCH FILM

C-1 The coverage mass per unit area of the sample, in gram per square meter (gsm) shall be as given in Table 4 when determined as per IS 7016 (Part 1). The permissible variation in the mass per unit area of the film shall be ±10 percent.

C-1.1 gram per square meter (gsm) = Film Thickness in micron × Compound Density in gm/cc; and

C- 1.2 Area of coverage from 1 Kg sheet =

$$\frac{1\,000}{\left(\begin{array}{c}\text{Compound Density}\\ \text{in gm/cc}\end{array}\right) \times \left(\text{Film Thickness in micron}\right)}$$

Table 4 Coverage Area of Polyethylene Mulch Film

(*Clause* C-1)

Sl No.	Thickness of Polyethylene Mulch Film (µ)	gram per square meter (gsm) (Compound Density -0.93 gm/cc)	Coverage Area from 1 Kg Sheet (gsm) (Compound Density -0.93 gm/cc)
(1)	(2)	(3)	(4)
i)	30	27.9	35.80
ii)	40	37.2	26.90
iii)	50	46.5	21.50
iv)	60	55.8	17.90
v)	75	69.75	14.30
vi)	100	93.0	10.75

ANNEX D

(*Clause* 5.6)

DETERMINATION OF SERVICE LIFE

D-1 GENERAL

The durability of mulching films is based on the climatic condition since mulch film are exposed to outdoor weather. Considering the total average solar irradiance of 160 kLy for India. The exposed UV lamp is used to determine effect of UV resistance of film. This need to be tested either in Xenon arc weatherometer or UV weatherometer to establish its life time. The film can be said to be deteriorated if the tensile strength at break and elongation at break falls by more than 50 percent of the unexposed samples.

D-2 EXPOSURE TO UV

D-2.1 Test Conditions

D-2.1.1 *UV Exposure*

D-2.1.2 *Cycle 1* (*see* ISO 4892-3)

D-2.1.3 *Lamp Type* — Type 1A (UVA-340)

D-2.1.4 *Irradiance* — 0.76 W/m^2/nm 310 nm

D-2.1.5 *Testing Cycle* — 8 h UV at 60°C

D-2.1.6 4 h Condensation at 50°C.

D-3 CORRELATION BETWEEN THE EXPOSURE IN FLUORESCENT UV LAMP AND NATURAL WEATHERING

The mulch film to sustain following hours of exposure to qualify for different life span as per Table 5.

D-4 CALCULATION

Total radiation of the spectrum of the sun in Indian regions is around 160 Kilo Langley per Year (kLy). Kilo Langley is the total energy in UVB, UVA, visible and IR region**.**

Calculation from kLy to MJ/m^2/nm is as follows:

$$\text{kLy} \times 41.84 \times 0.05$$

where,

41.84 is the conversion factor from kLy to MJ/m^2; and

0.05 is the fraction of the total solar radiation that is TUV approx 5 percent that is,

160 kLy × 41.84 × 0.05 = 334.72 MJ/m^2

= 3 34 720 kJ/m^2 (UV energy of 295 ~ 385nm (MJ))

So, 3 34 720 kJ/m^2 is TUV irradiance (Total UV energy)

UV energy at 340 nm (kJ) : 3 34 720 × 0.01 = 3347 kJ/m^2 (UV energy at 340 nm is around 1 percent of 295 ~ 385 nm)

UV Energy at 340 nm (E) = Irradiance (I) × time in hours (t) × Constant

$$E = I \times t \times C$$

3 347 = 0.76 × 3.6 × hours

Hours = 1 223 h UV light exposure.

Table 5 Duration of Exposure

(*Clause* D-3)

Indian Solar Radiant Exposure (kLy)	Duration of Exposure for an Expected Llifetime in Natural Environment					
	3 Month	6 Month	12 Month	18 Month	24 Month	36 Month
(1)	(2)	(3)	(4)	(5)	(6)	(7)
160	458	917	1 834	2 292	3 668	5 502

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Plastics Sectional Committee, PCD 12

Organization	*Representative(s)*
Central Institute of Plastics Engineering & Technology (CIPET), Chennai	Prof (Dr) S. K. Nayak (***Chairman***)
Central Institute of Plastics Engineering & Technology (CIPET), Chennai	Dr S. N. Yadav
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Shriram Institute for Industrial Research, Delhi	Dr P. K. Kaicker Dr R. K. Raina (*Alternate*)
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Indian Centre for Plastics in the Environment (ICPE), Mumbai	Shri T. K. Bandopadhyay Shri Arunava Guha (*Alternate*)
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Organization	*Representative(s)*
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Voluntary Organization in Interest of Consumer Education (VOICE), New Delhi	Shri M. A. U. Khan Shri H. Wadhwa (*Alternate*)
All India Plastics Manufacturers Association (AIPMA), New Delhi	Shri Deepak Ballani
Consumer Education Research Centre (CERC), Ahmedabad	Shri Raju D. Desai Shri H. S. Tripathi (*Alternate*)
The Toy Association of India (TAI), New Delhi	Shri Rajesh Arora Shri R. K. Verma (*Alternate*)
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National Committee on Plasticulture Applications in Horticulture (NCPAH), Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi	Shri Anand Zambre Shri Krishna Kumar Kaushal (*Alternate*)
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Amendments Issued Since Publication

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Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg CHANDIGARH 160019	265 0206 265 0290
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